Appl. No 10/614,261
Amdt. Dated Jun. 8, 2007
Reply to Final Office Action of Dec. 11, 2006

SPECIFICATION AMENDMENTS

A. Amendments to Specification

Applicant respectfully request that the specification be replaced with the following:

TITLE OF THE INVENTION

Apparatus For Computer Control By Laser-Speckle Patterns

TECHNICAL FIELD OF THE INVENTION

This invention relates to computer control and more specifically to the control of the marker cursor position as displayed by the corresponding computer monitor screen.

BACKGROUND OF THE INVENTION

Optical systems for the control of a computer marker cursor (also known as optical navigation devices) are well known in the art. These systems function by converting the motion of a handpiece (mouse) over a certain surface into quadrature signals that register the x-y position of the cursor marker. An example of this art is described in U. S. Patent No. 4,794,384 issued Dec. 27, 1988 to Jackson. Jackson's navigation device, illustrated in Figure 2 of his patent, shows an enclosure which rigidly houses a "PC BOARD" with attached "SOURCE" and "DETECTOR ARRAY CHIP" all moving as a whole over a special surface. The "SOURCE" projects a partially coherent source of light onto the surface. The scattered light characterized by Jackson as a speckle pattern is registered by the "DETECTOR ARRAY CHIP" and the "PC BOARD" electronically processes the array signal into cursor position coordinates, although an auto-correlation is not computed. Some limitations of this prior art can be noted. Jackson's invention does not separate the source and speckle generating means as an intact whole thus permitting the tracking of a general object such as the operator's head or finger, nor does his

invention employ an optically-sensed digitally-autocorrelated navigation chip which would make the system more reliable and robust.

Improvements in the art have led to more compact and robust electronic arrangements as shown in the prior art in Fig. 1. For example, the mouse components contain a navigation CMOS chip, U. S. Patent No. 6,631,218 issued to Badyal et. al. Oct. 7, 2001, an imaging lens, an incoherent LED light source, and a mouse interface electronics chip (Agilent Technologies, Technical Data HDNS-2000, e.g. Cypress CY7C63000A-PC). The basic function of this art is that of a 2-D detector array combined on the same chip with a digital signal processor (DSP) unit to digitally compute the autocorrelation function from which mouse position parameters are derived. The CMOS chip containing the sensor array and digital signal processor, mouse interface chip, LED, and imaging lens all move with the mouse housing as an intact whole over a special surface. The processing of the imaged pattern structure (image of the surface) is converted to quadrature outputs which control the cursor position. This art although more sensitive and compact than prior art forms has limitations similar to Jackson, namely, it does not provide a more general tracking application, nor does it incorporate application to the processing of laser-speckle patterns.

Other means of controlling a computer by movement other than a mouse are also known in the art. For example, Pelosi, U. S. Patent No. 6,424,410, discloses the use of a "complementary pair of emitter/detector units, one of which is worn on a part of a user's body (e.g. head) and the other of which is mounted in a stationary position or adjacent to a display screen," Col. 2 Lines 62-65. Each of Pelosi's complementary pair units has an emitter element emitting a cone shaped beam. Each unit also has an array of photodetectors to receive the light from the opposite unit. The position information is determined by a processing unit which

receives signals from each detector, essentially measuring the absolute intensities of the light received by each detector, Col. 3. Pelosi's device further computes the positioned coordinates by the use of a difficult form of curve-fitting on the outputs of each detector, a multi-segment solution routine, Col. 16. Pelosi's limitations are associated with the complexity of requiring multiple electronic signal communications between the movable unit and the stationary unit-processor. A further limitation is that the system being based on light intensity magnitude measurement is basically a multiplicity of high accuracy photometers, at least 8, which require repeated calibration as the curve-fitting is sensitive to intensity errors. Other than intensity, Pelosi's detection processor does not make use of any other properties of the light sources. Furthermore, Pelosi does not disclose means for tracking a body surface such as a finger tip, nor does his invention disclose the advantageous art of using an optically-sensed, digitally-autocorrelated navigation chip modified to process laser generated speckle patterns.

Still, a further example of optical control of a computer is the art discussed by Koisumi et al, U. S. Patent No. 5,883,616. Koisumi describes a headset mounted plurality of light emitting elements projecting unspecified type of light in (e.g. five) different directions. These light beams are projected to an array of equally numbered detectors arranged to receive light preferentially from (e.g. five) different directions, Cols. 5, 6, and 7. The outputs of the detector elements are measured for intensity. No other light characteristic is employed, Cols. 5, 6, and 7. Koisumi's detector array processor takes light intensity and produces positional data based on intensities. As in Pelosi, Koisumi's device is limited by the requirement of high accuracy photometers. Other than intensity, Koisumi's detector processor also does not make use of any other property of the light sources (e.g. speckle patterns,) nor does Koisumi disclose means for tracking other than head movement, nor does his invention disclose the advantageous art of using an optically-

sensed, digitally-autocorrelated navigation chip modified to process laser generated speckle patterns.

SUMMARY OF THE INVENTION

It is therefore the object of the present invention to overcome the limitation of the prior art and to provide a general and economic apparatus for computer control based on the use of laser-speckle light patterns and a laser-speckle receiving unit comprised of an optically-sensed digitally-autocorrelated navigation chip. Through this inventive combination, various body parts or other moving objects in general may be employed to control a computer cursor. It is to be understood that controlling the cursor position is tantamount to controlling a general machine on two parameters or conversely, also tracking the movement of such bodies in various combinations of two positional coordinates. It is therefore the object of the present invention to provide a computer control apparatus where the laser and the laser-speckle pattern generating means moves as an intact generating unit separate and apart from the laser-speckle pattern receiving means, thus controlling the computer by the motion (in any combination of two degrees of freedom) of the laser-speckle generating unit or the body to which it may be attached, such as the head. Conversely it is also the object of the present invention of providing measurement tracking means of said unit by observation of the cursor marker positions. It is a further object of the invention to provide a computer control apparatus where the laser and the laser-speckle pattern receiving unit are in fixed relation and the laser-speckle pattern is produced by the projection of a laser beam onto a moving body, such pattern moving in correspondence to the motion of the body. Thus this object renders the controlling of a computer by the motion of an independent body such as a finger tip by means of the laser-speckle pattern generated on its

surface or conversely the tracking of an independent body (a finger tip for example) in two coordinates by means of the laser-speckle pattern generated on its surface.

Still further features and advantages will become apparent from the ensuing description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is the prior art of Badyal, U. S. Patent No. 6,631,218, as it is employed in computer control. Fig. 2 is a preferred embodiment of the present invention. Fig. 3 is the application of the novel concept of the present invention applied to the control of the computer cursor by head movement of an operator or conversely tracking the movement of the operator's head. It is based on the attachment of the laser and laser-speckle pattern generating means as an intact whole on the operator's head. Fig. 4 depicts two methods known in the art for the generation of a laser-speckle pattern. There are other methods not depicted. Fig. 5 is the application of the novel concept of the present invention to the controlling of a computer cursor in two dimensions by means of the motion of a body (such as finger tip) or conversely the tracking of the motion of the body in two dimension, both derived from an autocorrelation of the projected laser-speckle pattern corresponding to the body movement relative to the fixed combination of the laser and an optically-sensed digitally-autocorrelated navigation chip receiver.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Fig. 2, the basic inventive concept of the present invention is noted as the combination of a laser, a laser-speckle pattern generating and projecting means and a modified optically-sensed digitally-autocorrelated navigation CMOS chip. This low cost chip can be obtained from Agilent Technolgies, viz. a HDNS-2000. The chip is designed to image, by means of a lens, LED illuminated surface patterns onto a 2-D detector array, to

mathematically determine in the digital domain the autocorrelation of the pattern to follow the pattern's movement and to output quadrature signals to control a computer. It has not been known or appreciated in the art until the present invention that this type of autocorrelating chip can be modified by removing the lens and the limiting aperture so as to allow the processing of laser generated speckle patterns. As is well known in the art, a laser generated speckle pattern remains time invariant as long as there is no movement of the laser beam relative to the speckle pattern generating means. Thus the laser speckle pattern generator and the laser taken as an intact whole becomes a unit that can be tracked (as in computer cursor movement) by motion of the unit relative to the sensor array upon which the speckle pattern is projected. Various means of producing a laser-speckle pattern are known in the art. These are illustrated in Fig. 4 as examples. Also, a laser beam projected transversely into a fiber optic bundle generates a unique laser-speckle pattern contained in a plane, Taboada U. S. Patent No. 5,898,809. The laser and the laser-speckle pattern generator unit as an intact whole can be attached to the body of an operator (as on the head) to track the movement of the operator's head as depicted in Fig. 4. The sensor is fixed to the computer and receives the laser generated speckle pattern and outputs control signals to the computer.

A further example of an application of the present invention is illustrated in Fig. 5. In this example, the laser and the laser-speckle pattern receiver, the optically-sensed digitally-autocorrelated navigation CMOS chip, are held fixed in relation to each other and the beam is projected onto a point on a movable body (e.g. a finger tip.) The laser generated speckle pattern resulting from the surface of the finger tip is received by the navigation chip. Movement of the laser-speckle pattern corresponds in this case to the movement of the finger tip. It will be appreciated that the foregoing features are examples derived from the basic inventive concept.

It is to be understood that the present invention is not limited to the embodiments described above, but encompasses any and all embodiments within the scope of the following claims.